

January 8, 2003

MEMORANDUM TO: William D. Travers  
Executive Director for Operations

FROM: Ashok C. Thadani, Director/**RA**/  
Office of Nuclear Regulatory Research

SUBJECT: OVERVIEW OF RESEARCH RELATED TO DEGRADATION OF  
CONTROL ROD DRIVE MECHANISMS

My staff in the Materials Engineering Branch is conducting research to address issues related to degradation of control rod drive mechanism housings. A summary of that work is attached to this memorandum. The summary describes the long- and short-term research programs addressing this issue.

The overall objective of the RES program is to derive and verify an integrated, probabilistic calculational methodology that can support evaluation of inspection techniques and intervals for vessel penetrations for long-term management of vessel head penetration (VHP) degradation and for incorporation in overall risk assessments. A pertinent interim analytical finding, specific to the Davis-Besse issue, is that the failure of the cladding under continued cavity growth was at least 12 months away, and time to failure is strongly dependent on the unquantified continuing wastage mechanism. It should be noted that the analyses have several uncertainties, including the effects of the crack in the cladding. The variables which have the largest effect on the analysis are currently being pursued as discussed in the summary. The basis for this finding is briefly discussed below.

The integrated program already addresses several recommendations made by the Davis-Besse Lessons Learned Task Force, particularly in the area of stress corrosion cracking. As a part of its ongoing research on the broad-scope issues of environmentally assisted cracking and evaluation of non-destructive examination techniques, the Materials Engineering Branch (MEB) redirected parts of these programs and established several research initiatives on various aspects of control rod drive mechanism (CRDM) cracking in particular, and VHP degradation, generally.

The particulars of the degradation at the Davis-Besse plant led to the redirection of the immediate efforts of several of these existing programs, and of my staff as well, to provide the support requested by NRR to properly disposition the activities of the licensee, to understand the content of the root cause report, to provide inputs necessary for the Significance Determination Process and Accident Sequence Precursor analyses, and to establish the fundamental parameters of the corrosion process for future reference. These efforts are short-term; some of them have been completed and a few others will continue for a few more months.

Significant progress has been achieved in several of the activities specific to Davis-Besse. For example, my staff completed a review of the published experiments on corrosion of pressure vessel steel by concentrated boric acid solutions. All of the credible experiments show that corrosion rates increase as the boric acid concentration, and aeration of the solution increases, which is no surprise; corrosion rates also increase as the temperature decreases, reaching a maximum at about the ambient pressure boiling point of the solution. Coupled with the leakage rates and evaporative cooling associated with the Nozzle #3 crack, this information provides a credible explanation for the rate of cavity corrosion found at the plant.

Concurrent with the RES staff review of corrosion data, MEB re-directed some of the contracted resources at ORNL to develop a model of the Davis-Besse head, including the cavity, and compute (a) the margin of overpressure that the reactor vessel could support without rupture of the cladding at the bottom of the cavity, and (b) the size to which the cavity could have enlarged before the cladding would have ruptured at normal operating pressure and temperature. This overview details the results of the ORNL calculations, specifically that the as-discovered cavity could have supported over twice the normal operating pressure. Secondly as discussed above, had the cavity enlarged under continued operation, at least 12 months remained before the cavity would reach a size that rupture would occur at normal operating temperature and pressure.

Lastly, my office is sponsoring a conference on degradation of nickel-base alloys, including head penetrations and mixed metal attachments. This conference will be held on March 24 - 26, 2003. We expect a large turnout of international and domestic engineers, researchers and regulators having a special interest in this active and rapidly developing topic.

Please contact me if you need any additional information or clarification.

Attachment: Overview of U. S. Nuclear Regulatory Commission Research to Address Issues Related to Degradation of Control Rod Drive Mechanisms in U. S. Nuclear Power Plants

William D. Travers

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